

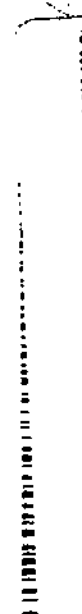
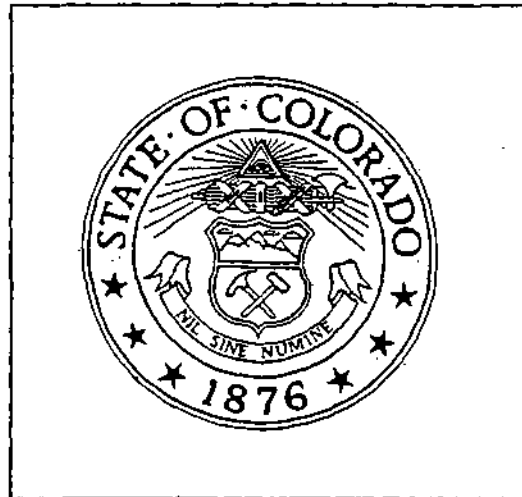


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COLORADO DEPARTMENT OF PUBLIC HEALTH
AND THE ENVIRONMENT

HAZARDOUS MATERIALS AND WASTE MANAGEMENT
DIVISION

SOILS STUDY
RICO, COLORADO



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SOILS STUDY, RICO

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INTRODUCTION

In August 1996 a team composed of representatives from the State of Colorado and ARCO collaborated in a study aimed at confirming sources for previously-documented elevated Pb levels found in residential soils in and around the Town of Rico, Colorado. Participating from the State of Colorado were James Lewis, Robert Kirkham, and Mark Walker and ARCO consultants and representatives were, Richard Elliot, Travis Hudson, Terry Moore, and Michael Russ (site examination only). The site studies were conducted August 6-8, 1996.

The ore bodies in the Rico Town Area (RTA) are relatively near surface as the mine workings are not developed at great depth, and one, the Atlantic Cable, was sunk on outcropping mineralization. This fact was confirmed during a site visit on August 6, 1996 when the team observed a gossan deposit northeast of town, which represents the ferruginous deposit of the upper oxidized portion of a sulfide vein. The predominant ore deposits of RTA consist of 1) massive sulfide replacement deposits in limestone of the Hermosa; 2) contact metamorphic deposits of sulfides, specularite, and magnetite in limestones and 3) veins in fractures and small faults in lower Hermosa sandstones and arkoses (McKnight, 1974). The most abundant sulfide mineral is pyrite (iron sulfide). Other common sulfide minerals are sphalerite (zinc sulfide), and galena (lead sulfide).

Bedrock units underlying the site include the middle member of the Hermosa Formation, Leadville Lawson Latite Porphyry, and the Uncompahgre Quartzite. The middle member of the Hermosa is composed of interbedded limestone, arkosic sandstone, and shale. There are intermittent outcrops of the Precambrian Greenstone. A wedge of coarse alluvial/colluvial valley fill is within the Dolores and Silver Creek drainage basins (ARCO, 1996A, Figure 2-16).

In the course of the history of RTA, it is known that ~~two~~ ~~smelters operated, the Grand View, and the Pasadena Smelters.~~ Both smelters had limited operations, and ceased operations prior to the turn of the century. At least two mills operated using the floatation system, the Pro Patria and the Rico-Argentine Mills. Outside RTA, two tailing ponds resulted from the

~~Operations of these mills and remediation of these ponds was performed under the Colorado Voluntary Cleanup and Redevelopment Act in 1996. Several waste rock piles next to former mine workings are locally visible in the RTA and its surroundings. In addition to mining and related industries, an acid production plant operated north of town, producing sulfuric acid from pyritic ores.~~

The mineralogy of lead is a factor to consider in assessing the origins and characteristics of specific Pb sources. Exposure of lead ores to surface weathering (hydrolysis and oxidation) will chemically alter the original mineralogic state.

~~A previous effort performed by ARCO and others identified elevated total Pb levels in residential soils in the RTA. Levels detected range from ND - 49,500 ppm. ARCO had concluded many of the elevated lead levels were concentrated in the colluvial soils of the northeast section of RTA, though the range of values among samples was large. ARCO concluded that the elevated levels found in the soils of RTA had natural sources - the likely contributor being weathering of the mineralized bedrock in the district - and the extent of anthropogenic sources, such as mill tailings, fill material and mine waste rock were separately identified and mappable (ARCO, 1996B, Elliot, 1996).~~

~~A Site Inspection performed under contract to EPA Region VIII identified elevated Pb levels in residential soils. Three samples exceeded 3 times background. Pb levels ranged from 673, 2620 ppm, (EPA, 1996).~~

~~A Phase I & II Environmental Audit collected a soil sample which exceeded regulatory limits for TCLP-Pb. This sample was collected within the RTA (Walsh, 1995).~~

All of the aforementioned sources of Pb in the RTA may have contributed in some form or another to the total lead found in previous soil sampling efforts. The intent of this study was to confirm or refute the results of previous studies as to the sources of elevated Pb levels in the soil. In addition the intent was to investigate other sources in RTA which had significant total Pb levels.

RC-2E Same location and sieving as RC-2D. Interval begins at the base of RC-2D and is 24" thick. Matrix is approx 25 % and is sandy silt. No effervescence.

RC-2F Same location and sieving as RC-2D&E. Top of sample interval begins at base of RC-2E and extends down to bottom of hole, total length of sample interval is 26". Matrix is reddish-brown silty sand and is less than 25%. Clasts range from small pebbles to boulders up to 2' diam. Most clasts are <2" diam. Clasts include limonitic, iron-stained clasts. Clasts are weathered. Clasts are dominantly angular to sub-angular. No effervescence.

RC-3 Location is the Silver Creek alluvial fan, 5% westerly aspect. Purpose of this sample is an attempt to replicate a previous sample collected by EPA in their Site Inspection of Rico. Surface (A Horizon) is truncated. Present are clay loam textured materials. Fines are 10YR4/3 (est), very few fine roots decrease to bottom of exposure, no effervescence, unvegetated. Overall, coarse fragments (>10cm) comprise 20% of volume, consisting primarily of latite porphyry; 30% by volume gravel-sized fragments of porphyry and sandstone predominantly rounded; 50% loam. Noted mineralization among fragments (iron oxides, iron oxide after pyrite). No vegetation noted.

RC-3A	0-14" depth, sieved to <mm
RC-3B	14-28" depth, " " "
RC-3C	29-42" depth, " " "

RC-4 Location is former site of Grand View Smelter. Purpose of this sample series is a demonstration of any impact from smelting operations. Sampling scheme consists of collection of three samples surrounding the former smelter collected from soils which appear to be undisturbed since smelter operations ceased. Locations are described from a Central Point (CP) which is located approx 47 lateral feet N25°W from the SW corner of the Core Building shown in Figure 1-4 of the Grand View Smelter Application.

- RC-4A Location is south of former smelter, specifically, S10°W from CP approximately 150 lateral feet. Sample location has a 45° westerly aspect. Vegetation consists of grasses, vetch, aspens (<6" diam). Site is approx 40' downslope from road base material of similar consistency to Van Winkle Mine Dump. Approx 15' from the sample location is a dump consisting of glass and brick material. Soil does not effervesce. Sample from 0-6" depth and sieved to <mm, consisting of abundant fine/medium roots, moderate sub-angular blocky structure to soil and weak granular structure to soil. Soil is loam with 5% gravel-sized fragments (latite, Hermosa, no mineralization). Color is 10YR4/3. Aspen trunks >6" had curvature suggestive of local downslope movement, while trunks of 2.5" diameter, were straight. Site is colluvium which is excessively drained to the SW.
- RC-4B Location is east of the former smelter, and S78 degrees E from CP which is approximately 265 lateral feet from CP. 30° slope, somewhat eroded. Vegetation is grasses, composites, gooseberries. Aspens 5" in diam with slight trunk curvature. Site is colluvium. Location is 7' above a bench of Hermosa sandstone outcrop. Westerly aspect, excessively drained to SW. Soil does not effervesce. Soil is moderate/medium granular structure, abundant fine/med roots, 5% gravel mostly angular sandstone fragments, loam texture, color is 10YR3/3. Sample is A Horizon 0-6", sieved to <2mm, with a small amount of charcoal (removed from sample, likely due to uncontrolled fire).
- RC-4C Location is N40°E approximately 425 lateral feet from CP. 40% slope, colluvium (from greenstone). 12' downslope is a greenstone outcrop. Site is 30' downslope from a road cut, vegetation is mixed composites and grasses, some vetch, and few aspen seedlings. Westerly aspect, somewhat excessively drained, real erosion apparent. Sample is weak/medium sub-angular blocky and moderate/medium

granular structure. 10% gravel of angular greenstone fragments, color is 10YR4/4. No effervescence. Sample is 0-6" A horizon, sieved to <mm.

RC-5 Location for the "5A" series of samples is a road cut approx 1.6 mi N of the Dolores River Bridge on Highway 145 at Rico. Location is an outcrop of the Hermosa (Lower Member). Numerous faults were noted as exposed in the road cut with weak to moderate hydrothermal alterations. Most prominent fault has associated tufa deposit. The rock material collected is representative of the least-altered material. Location of the "5B" series of samples is a road cut approx 3 miles south of Rico on Highway 145 (S of Scotch Creek) and the series is representative of the unaltered Hornblende Latite Porphyry. Purpose of all these samples is to demonstrate a "background" nature of the unmineralized bedrock units.

RC-5A1 Sample is a composite of two limestone outcroppings described as follows: Limestone is medium gray, very fine grained, slightly fossiliferous, dense, strongly jointed, weathering to angular pieces. Minor calcite coating on joint surfaces. No obvious hydrothermal alteration. Second outcrop is described as medium gray, very fine grained, slightly fossiliferous, moderately jointed, dense, weak calcite and limonite on joint surfaces. No obvious hydrothermal alteration.

RC-5A2 Sandstone is coarse to very coarse, light greenish-gray, predominantly quartz grains with minor feldspar and approx 1% pyrite predominantly euhedral approx 0.1-0.2 mm in size. Sandstone beds greater than 1' in thickness. No obvious hydrothermal alteration.

RC-5A3 Shale unit is described as follows: Silty shale, med to dark gray, micaceous, somewhat fissile, thinly-laminated beds. No obvious hydrothermal alteration.

- RC-5B Hornblende Latite Porphyry outcrop. Outcrop is a thick sill intruding the Rico Formation. Hornblende Latite Porphyry is relatively fresh, with no obvious hydrothermal alterations. Composed of hornblende and plagioclase feldspar phenocrysts in a light gray groundmass. Estimated 1% opaque grains in groundmass.
- RC-6 Location is 20' SE of the SE corner of the former Assay Building in downtown Rico. Intent of this sample location is characterization of the ancestral Silver Creek Alluvial Fan. Description of the sampling location generally is as follows: 0-2" is locally disturbed and mixed material. Contains 30% rounded fragments of latite porphyry, sandstone, shale (mineralized). 2-8" interval, loamy texture with abundant fine/med roots, weak sub-angular block, mod/med granular structure, 15% coarse rounded and angular fragments of sandstone, shale (some iron coating) latite porphyry, slag. Soil has slight effervescence "Buried A-Horizon". Vegetation is primarily grasses and color is 10YR4/4.
- RC 6A Fine fraction (<mm) of 2-8" undisturbed interval noted in above description.
- RC-6B Coarse fraction of 2-8" (>mm) interval described above.
- RC-7 Locations are a series of sites progressing southward along a hillside moving away from the former location of the Acid Plant. Purpose of this sample series is to ascertain any impact due to the former Acid Plant.
- RC-7A Sample location is approximately 350' SE of the Lime Plant (@ St Louis Tunnel) on a hillside of colluvium derived from Hermosa formation, as the location is 100 vertical feet below an outcrop. Noted remnants of dead trees surrounding the site (likely due to acid deposition). Site is generally excessively drained with some sheet erosion. Vegetation consists of abundant raspberries and grasses. Slope is approx 60% with

a westerly aspect. Sample is mod/med granular, abundant med/fine roots, approx 30% gravel of Hermosa angular fragments; color is 10YR4/4. Loamy texture, sieved to <mm. Less mineralization (identified by Fe staining) was observed than the RC-4C sample taken just to the south of this location.

RC-7B Location is approximately 475' SE of Lime Plant noted above. Westerly aspect of 60-70% slope. Well drained site with slope wash and talus of Hermosa sandstones, noted 100' upslope. Soil described as colluvium on an unstable slope susceptible to sheet erosion. Vegetation is primarily broadleaf plants, some sapling aspens, and abundant raspberries. Sample is described as follows: A Horizon (0-6"), sieved to <mm, consisting of 40% gravel angular fragments of Hermosa sandstone. No mineralization, strong med granular structure with many fine roots, clay loam texture. Color is 10YR4/4. No effervescence noted. Sample was removed from between the cobbles.

RC-8 Location is 500' N of Smelter Fault just above the road to the Lime Plant noted above. Sample series is representative of the Greenstone and its contribution to the local mineralogy.

RC-8A Sample is a 10' chip sample across the outcrop face (total wt. approx 5 lbs). Greenstone is dark greenish-gray, weakly foliated, fine-grained, phyllitic, chloritic, with fine epidote crystals on fractures. Greenstone contains a few narrow metamorphic quartz lenses and weak limonitic coating on sparse fractures. Contains very minor quartz-specularite-pyrite-epidote pods and stringers.

RC-8B Soil sample from A&B Horizons from the same location as RC-11, and sieved to <mm. Depth sampled was from 0-8". A Horizon is 0-6" and B is 6-8". A Horizon is med/dark brown, slightly

gravelly, sandy silt, same as RC-11. B Horizon is medium reddish to yellowish brown, slightly gravelly clayey silt. Moderately organic with moderate vegetative matter (mostly roots). Non-calcareous with clasts same as RC-11.

RC-9 Sample series is located approximately 55' due E of the RC-3 series of samples. Purpose of this series is to demonstrate the "extent" of the anthropogenic effects seen in the RC-3 series. In comparison to RC-3 samples, this location does not have a truncated A Horizon within the 0-24" interval (an obvious A Horizon is present). Vegetation at this location is primarily grasses and willows.

RC-9A Location is 0-24". Sample sieved to <mm. Weak sub-angular blocky, mod/med granular structure. Roots are abundant, fine/med at surface which grades to many fine at the base of the interval. Soil texture is loam, possibly clay loam. Color is 10YR3/3. Soil does effervesce, slightly. Of the total volume, 10% is >10 cm; 30% are gravel-sized fragments of latite porphyry, sandstone, and shale; 60% is <mm loamy material.

RC-9B Location of sample is 24-49". Sample sieved to <mm. Soil is sandy loam red-brown with color approximated as 7.5YR4/3, some bodies are 2.5YR3/3 silty clay loam. Of the total volume, 50% are boulders (>10 cm; Latite porphyry, sandstone, shale); 20% gravel sized material consisting of rounded fragments of Latite Porphyry, sandstone, shale. Red coloration in soils is due to deterioration of Permian rock, not mineralization. Iron-oxide-after-pyrite presence was noted.

RC-10; Duplicates

RC-10A Duplicate of RC-5B
RC-10B Duplicate of RC-9B
RC-10C Duplicate of RC-16A

- RC-16 Location is Block 1, Lots 36-40 in Rico at the corner of Mantz & Glasgow Streets. Sample was collected to replicate results obtained in sample RS-02 of the Phase II Environmental Audit done by Walsh; this was the sample that failed TCLP for Lead. Site is described as original slope of 3% with a westerly aspect. Location of the lot is at the base of an industrial fill area where fill composed of the following was noted: alluvium, timber, treated poles, fragments of pipe, pipe fittings, glass, PVC, disintegrated grout containers. 20' farther uphill to the E, from the edge of the fill area is buried and burned construction debris. Filled area is storage location for natural gas materials. 90' to the NE are two Aboveground Storage Tanks marked "CLR DSL" and "REG". Vegetation at the site is composed of a dense stand of grasses with willows and other trees at the edge of the fill, some composite species. Sample is described as clay-loam texture, color was 10YR3/3 with abundant fine/med roots, weak med sub-angular block, mod/medium granular structure. 10% by volume was gravel-sized fragments of sandstone, shale, latite porphyry. No obvious mineralization of gravel-sized components. 90% by volume was <mm. Sample was sieved to <mm.
- RC-21 Exposure in foundation excavation behind the church in Rico. Excavation is cut into a 25% slope with a westerly aspect. Minimal erosion was noted, but some float from the roadway approx 20' upslope was seen. Vegetation consists of spruce and aspen. Aspen of 2" diameter show pistol-butting of trunks, large aspen and spruce do not. Sample site is well drained. Sample site is located approx 75' N of Van Winkle Mine Dump.
- RC-21A Sample depth is the A Horizon, 0-11". Sample sieved to <mm. Color is 10YR4/3 (approx). Clay loam texture. Structure is moderate, medium sub-angular blocky and weak medium granular structure. <5% cobbles, greater than 5 cm, consisting of sandstone and latite porphyry. Approx. 15% gravel-sized fragments consisting predominantly of sandstone and latite porphyry. Many med roots. Gradual boundary. Very slight effervescence.

- RC-21B Sample depth is 11-26", B Horizon. Color is 10YR4/4, clay loam texture. Mod/med sub-angular blocky structure, common fine and med roots. Approx 5% cobbles >10 cm. Approx 20% gravel-sized porphyry and sandstone fragments. Approx 75% fines. No effervescence noted.
- RC-21C Sample depth is 26-40+", C Horizon. Color is 7.5YR4/4. Sandy loam structureless, common med roots. Approx. 25% cobbles >10cm, consisting primarily of quartzite with some sandstone and porphyry. Approx. 30 % gravel-sized fragments of similar composition. No effervescence noted.

The following samples were collected for electron microscopy analysis and metal speciation:

- RC-11 Location is on a relatively flat bench 20' E of Greenstone outcrop sample location of RC-8 series. Soil sample is from the A Horizon, sieved to <mm, and collected from 0-2". Soil is med-dark brown, slightly gravelly, sandy silt, highly organic, abundant vegetative matter in sample (mostly roots). Non-calcareous, no effervescence. Sample composed of gravel clasts (greenstone, metadiorite, and sandstone).
- RC-12 Location is the new house under construction owned by M. Turrin. Same location as the RC-2 series. Sample is the coarse fraction (>mm) of the A Horizon similar to RC-2A.
- RC-13 Same location as RC-12, RC-2A, Turrin house. Sample is the fine fraction (<mm) of the A Horizon of undisturbed colluvium.
- RC-14 Same location as RC-3A. Fine fraction, <mm.
- RC-15 Duplicate sample collected at same location as RC-16A, sieved to <mm.

The following samples were submitted for Clay Mineralogy Analysis

RC-2A&C, RC-3A, RC-4B&C, RC-7A&B, RC-9A

The following samples were submitted for Cation Exchange Capacity Analysis

RC-2A&C, RC-4B, RC-7B

The following samples was submitted for TCLP-Pb Analysis

RC-15 (Duplicate of RC-16A)

RESULTS

TABLE 1: RICO SOIL SAMPLING RESULTS			
SAMPLE NAME	SAMPLE LOCATION DESCRIPTION	PH	TOTAL LEAD (PPM)
RC-2A	TURRIN, 10' EXPOSURE; A HORIZON, 0-23"	5.18	220
RC-2B	TURRIN, 10' EXPOSURE; B HORIZON, 23-55"	5.77	75
RC-2C	TURRIN 10' EXPOSURE, 55-78"	5.34	69
RC-2D	TURRIN; PILLAR EXC, 26" INTERVAL BEGINNING AT BOTTOM OF B HORIZON	5.98	1200
RC-2E	TURRIN; PILLAR EXC, BEGINNING AT BOTTOM OF RC-2D, 26-50"	6.27	3000
RC-2F	TURRIN, PILLAR EXC, 50-76"	6.27	3600
RC-3A	SILVER CREEK ALLUV FAN, ORE LOADING AREA, 0-14"	6.21	5600
RC-3B	SAME AS 3A, 14-28"	5.45	550
RC-3C	SAME AS 3A, 29-42"	5.53	660
RC-4A	GRAND VIEW SMELTER; SOUTH SAMPLE 0-6"	NA	2200
RC-4B	SAME AS 4A, EAST OF SMELTER, 0-6"	6.65	7000
RC-4C	SAME AS 4A; NORTH OF SMELTER, 0-6"	6.51	240
RC-5A1	LIMESTONE OUTCROP OF UNMINERALIZED HERMOSA FORMATION, N OF RICO	NA	14
RC-5A2	SANDSTONE OUTCROP OF UNMINERALIZED HERMOSA FORMATION, N OF RICO	NA	72
RC-5A3	SHALE UNIT OF UNMINERALIZED HERMOSA FORMATION, N OF RICO	NA	8.9
RC-5B	HORNBLende LATITE PORPHYRY, UNMINERALIZED, S OF RICO	NA	ND
RC-6A	FINE FRACTION (<2MM) NEAR FORMER ASSAY BLDG, ANCESTRAL ALLUV FAN	7.15	1100

TABLE 1: RICO SOIL SAMPLING RESULTS

SAMPLE NAME	SAMPLE LOCATION DESCRIPTION	PH	TOTAL LEAD (PPM)
RC-6B	COARSE FRACTION (>2MM) NEAR FORMER ASSAY BLDG, ANCESTRAL ALLUV FAN	NA	340
RC-7A	FORMER ACID PLANT, 350' S OF EXISTING LIME PLANT	5.81	130
RC-7B	FORMER ACID PLANT, 475' S OF EXISTING LIME PLANT	6.03	86
RC-8A	10' CHIP SAMPLE OF GREENSTONE OUTCROP N OF RICO	NA	38
RC-8B	A&B HORIZONS OF SOIL DERIVED FROM GREENSTONE BEDROCK	6.15	1000
RC-9A	55' E OF RC-3, SILVER CREEK ALLUV, NO ANTHROPOGENIC EFFECTS, 0-24"	6.25	330
RC-9B	55' E OF RC-3, SILVER CREEK ALLUV, NO ANTHROPOGENIC EFFECTS, 24-49"	6.75	570
RC-10A	DUPLICATE OF RC-5B	NA	ND
RC-10B	DUPLICATE OF RC-9B	NA	430
RC-10C	DUPLICATE OF RC-16A	NA	110
RC-16A	BLOCK 1, LOTS 36-40 CORNER OF MANTZ AND GLASGOW, 0-6"	6.74	110
RC-21A	A HORIZON, 0-11", FOUNDATION EXPOSURE BEHIND CHURCH	6.77	1800
RC-21B	B HORIZON, 11-26", FOUNDATION EXPOSURE BEHIND CHURCH	6.97	1300
RC-21C	C HORIZON, 26-40+", FOUNDATION EXPOSURE BEHIND CHURCH	7.08	2300

DISCUSSION AND CONCLUSIONS

Previous sampling efforts had identified elevated levels of Pb in the soils in and around the Town of Rico, Colorado. The intent of this study was to confirm or refute the results of previous studies as to the sources of elevated Pb levels in the soil. In addition the intent was to investigate other sources in RTA which had significant total Pb levels.

It is apparent from visual observations that the RTA has residual anthropogenic sources of Pb. This conclusion is confirmed by the speciation of Pb phases performed on RC-14 and shown in Appendix A. Most common under "frequency of occurrence" within the total population of lead phases present is "slag". Visual observations of the former ore transfer station and load-out facility identified numerous pieces of primary Pb phase ore. The sample description for Sample RC-3A which is co-located with RC-14, describes the A horizon as "truncated", indicative of anthropogenic disturbances. Total Pb for RC-3a was 5600 ppm. Out of the total Pb mass at this location the most significant contributor is "Native Pb" as determined by speciation of RC-14. This location is indicative of one source of lead which is not naturally-occurring and it was recognized and mapped separately as such in previous work (ARCO, 1996B).

In contrast, sample RC-9A which was located 55' east of RC-3A has a single order of magnitude decrease in total Pb, indicating the areal extent of the impact described by RC-3A results is limited, as previously mapped. In fact, it should be noted that RC-9A is representative of the native A Horizon and could be closely related to the results from RC-3B, which also demonstrated a similar decrease in total Pb levels from the sample retrieved immediately above (RC-3A).

The RC-2 series of samples seems to be a confirmation of previous investigators results. It was determined that the native colluvium in the area of Rico had elevated levels of lead which were naturally occurring. The source of the total Pb burden appeared to be weathering of the near surface mineralized bedrock (ARCO, 1996B). The sample location for RC-2 series was located in the NE part of town close to a mineralized fault. The sample description notes the samples were taken from a foundation

excavation of undisturbed colluvium. Total Pb levels in this series were consistently above 1000 ppm in the samples whose descriptions included indications of angular clasts which had been hydrothermally altered. No anthropogenic sources of Pb were noted in the immediate vicinity, leaving one to conclude that the sources of the total lead must be the clasts which derived from the mineralized parent rock.

The sample description for RC-21 does not note any mineralized clasts, though the sample location was an apparent undisturbed foundation excavation in the colluvium with no immediately apparent man-made sources visible in the profile or on the surface. The source of the elevated levels (>1000 ppm) is less clear, though lacking speciation data and a visible anthropogenic source, one must suspect the Pb found has a natural source. Further support for this conclusion comes from the observation that the sample location has primary sulfide mineralization outcropping upslope and Pb levels are stratified (concentrations increasing with depth), suggestive of near-surface mineralization at this location.

The intent of the RC-5 and RC-8 series was a demonstration of the contribution to the area's soil Pb burden by the unmineralized bedrock. It was adequately demonstrated that the host Hermosa is not a significant contributor of soil Pb unless it is mineralized. It is clear from the RC-8A results that the sample from the Precambrian Greenstone is not a source of soil Pb, though a single sample cannot eliminate the Greenstone as a Pb source, as the Greenstone can be locally mineralized (McKnight, 1974, Hudson, 1996). It is less clear as to the source of the significant Pb in the soil above the Greenstone, perhaps this sample location had been impacted by colluvium from the Hermosa above on the hillside. Speciation of Pb phases suggests that Pb compounds are not of a mining origin at RC-11 (Drexler, 1996B).

Series RC-6 was an attempt to ascertain the background levels present in the ancestral alluvial fan of Silver Creek. What were sampled were the coarse and fine fractions of a buried (by fill) A horizon. Whether the Pb found in the fine fraction had migrated downward from the fill material is unknown as the fill material was noted as having mineralized clasts. The coarse fraction did have significantly less total Pb than the fine fraction. Differences in the fine and coarse materials at RC-6

may reflect the extractability of lead in the fine (<2mm) vs coarse (>2mm) fractions of the soil. The surface area is also much greater than materials from the coarse fraction. The higher Pb concentrations found for RC-6 (fine fraction) may reflect greater extractability and not greater total Pb. On the other hand, accumulation of Pb in the fine fraction by natural weathering is also possible. At the high pH values present in sample RC-6 (pH=7.15), weathering of Pb minerals is very slow, however (Moore, 1996).

With respect to RC-16, the intent was replication of a previous sample which had failed TCLP for Pb. Manmade sources of Pb in the immediate vicinity of the sample location were identified. These include slag (RC-15), fill material and two aboveground storage tanks which may have contained leaded gas at one time. The sample submitted for TCLP analysis was within regulatory limits and the total Pb results for the soil sample were among the lowest recorded in this study.

Sampling of Series RC-7 was intended as an indication of impact from the acid plant which had operated in close proximity. Clay mineralogy analysis did not indicate extensive acid impact to the soil. Although the vegetation present at the sample sites was indicative of an acid soil (raspberries) the stand of vegetation did not appear significantly different from the area in general. Young live aspens were visible, in contrast to the stumps of trees still visible, likely from the time the plant last operated. Soil Pb levels were some of the lowest obtained in the course of this study. Soil pH at RC-7A was medium acid (pH=5.81, Soil Survey Staff, 1951) which was consistent with surface soils weathered from mineralized Hermosa formation colluvium in other areas of Rico assumed to be outside the zone of influence of acid plant operations (Moore, 1996).

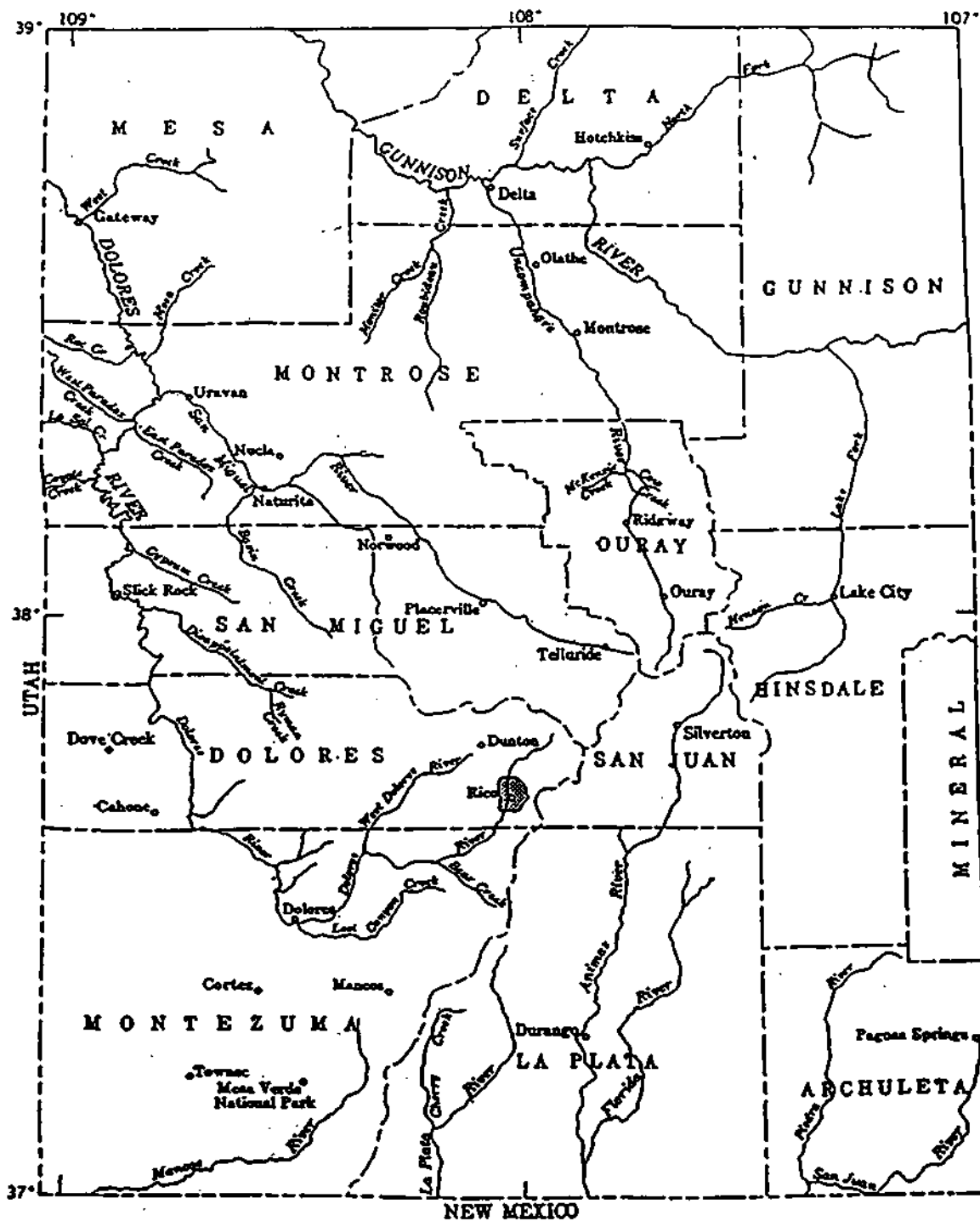
The intent of the RC-4 series was to ascertain if there has been any impact due to operations of the former Grand View Smelter. RC-4B had the highest total Pb content of the samples collected in the study, though multiple party analyses of this same sample yielded diverse values for total lead, ranging across one order of magnitude (from approximately 700ppm-7000ppm). RC-4A also had significantly elevated levels of total Pb. Speciation of RC-4B

revealed that ~~there was a trace of Pb oxide present in the~~ sample, indicative of exposure of lead to a high oxygen environment, possibly smelting or weathering of sulfidic minerals (Drexler, 1996A&B). Soil at this location was likely formed from the upslope colluvium which may have had mineralization. The mineralized nature of this sample was demonstrated when the soil sample was found to contain pyrite at a concentration of 0.3% by weight (Moore, 1996). The sample description of RC-4B did not note any mineralized clasts present in the soil.

In summary, multiple conclusions have been reached by the team involved in the collaborative sampling of Rico, Colorado.

1. ~~Natural~~ sources of elevated lead levels are present in the RTA. These sources are related to the exposure of and weathering of mineralized bedrock and characteristically contain lead-bearing manganese and iron oxide phases that are produced by the oxidation and hydrolysis of original mineral assemblages.
2. ~~Anthropogenic~~ sources of elevated lead contents are present in the RTA. These sources include ~~mine waste rock, mill tailings, and smelter slag~~. These mining-related wastes are physically and mineralogically different from the materials derived from the erosion and weathering of mineralized bedrock and their distribution can commonly be mapped separately where they are significant sources of lead in surface materials.
3. ~~Long lasting impacts~~ on soil properties resulting from the operation of the acid plant appear to be minimal.
4. An ~~effort~~ to identify smelter emission products was inconclusive. The short life of smelters, the small amount of lead they processed, and the prevalence of other lead sources in numerous samples collected suggests that smelter emissions are not an important control on observed lead distribution in RTA. ~~To fully delineate any smelter impact would require a more extensive sampling effort than the one undertaken for this study.~~

FIGURES



RICO DISTRICT
LOCATION MAP

FIGURE 1

APPENDIX A

REPORT ON LEAD SPECIATION PERFORMED BY UNIVERSITY OF COLORADO

1.0 INTRODUCTION

Five soil samples were hand delivered to LEGS by represents of the CDPH for lead speciation analysis using electron microprobe techniques. Sample RC-12 was composed of large rock fragments and was first crushed. Samples were air dried and sieved to less than 2mm. A portion of the sample was placed into a plastic mold and filled with epoxy, and allowed to air cure. The sample "puck" was removed and polished and carbon coated for EMPA analysis.

2.0 RESULTS

Frequency of lead phase distribution along with relative lead mass are presented in Figures 1-5. Counting errors are given in Table 1 for those samples which had a statistically meaningful particle count. Bulk EDSXRF analyses are given in Table 2.

3.0 Method

EMPA

Metal speciation was conducted on a JOEL 8600 electron microprobe (EMPA) at the Laboratory for Geological Studies at the University of Colorado following the laboratories SOP. With the exception that the < 250 μm size fraction was used for speciation. Representative backscatter photomicrographs (BSPM) illustrating sample characteristics were acquired.

Data from EMPA will be summarized using two methods. The first method is the determination of FREQUENCY OF OCCURRENCE. This is calculated by summing the longest dimension of all the metal-bearing phases observed and then dividing each phase by the total. Equation 1.0 will serve as an example to the calculation.

F_{Metal} Frequency of occurrence of metal
in a single phase.

PLD - An individual particles longest
dimension

$$F_{\text{Metal}} \text{ in phase-1} = \frac{\sum (\text{PLD})_{\text{phase-1}}}{\sum (\text{PLD})_{\text{phase-1}} + \sum (\text{PLD})_{\text{phase-2}} + \sum (\text{PLD})_{\text{phase-n}}}$$

$$\%F_{\text{Metal}} \text{ in phase-1} = F_{\text{Metal}} \text{ in phase-1} * 100$$

This data thus illustrates which metal-bearing phase(s) are the most commonly observed in the sample or relative volume percent.

The second calculation used in this report is the determination of RELATIVE METAL MASS. These data are calculated by substituting the PLD term in the equation above with the value of M_{Metal} . This term is calculated as defined below using the data in Table 3.1.

M_{Metal} - Mass of metal in a phase

SG - Specific Gravity of a phase

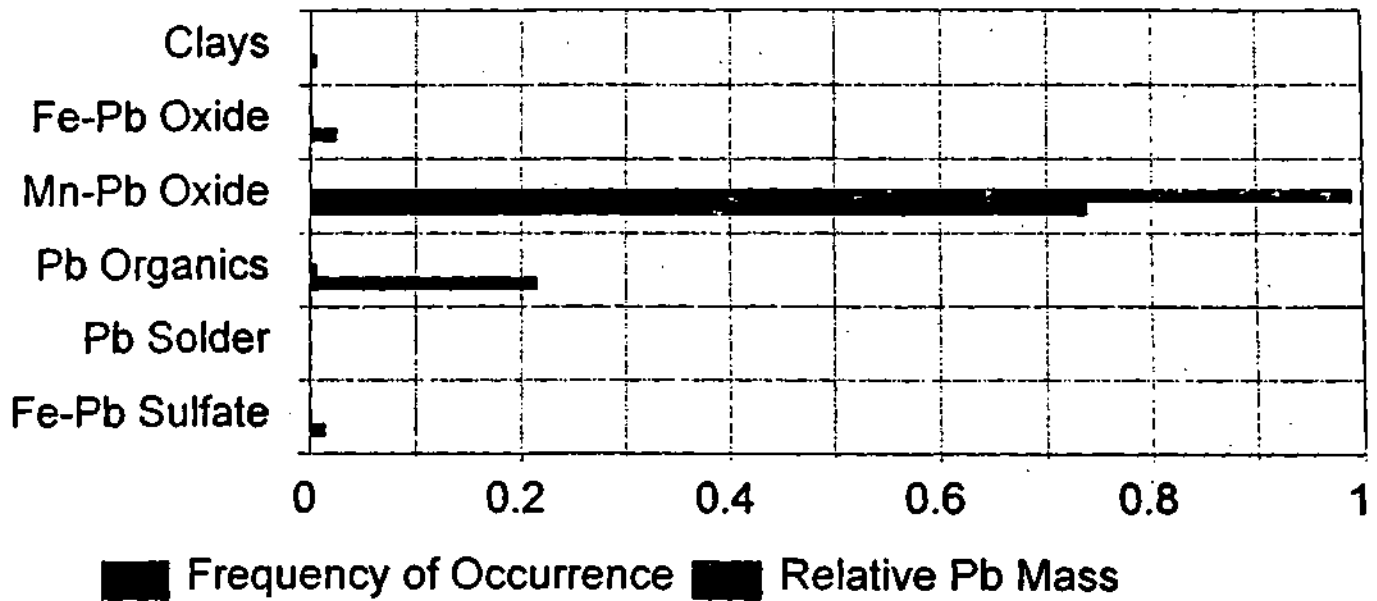
ppm_{Metal} - Concentration in ppm of metal
in phase

$$M_{\text{Metal}} = F_{\text{Metal}} * SG * \text{ppm}_{\text{Metal}}$$

The advantage in reviewing the RELATIVE METAL MASS determinations is that it gives one information as to which metal-bearing phase(s) in a sample are likely to control the total bulk concentration for the metal of concern. As an example, PHASE-1 may by relative volume comprise 98% of the sample, however it has a low specific gravity and contains only 1000 ppm arsenic, while PHASE-2 comprises 2% of the sample, has a high specific gravity and contains 850000 ppm of arsenic. In this example it is PHASE-2 that is the dominant source of arsenic to the sample.

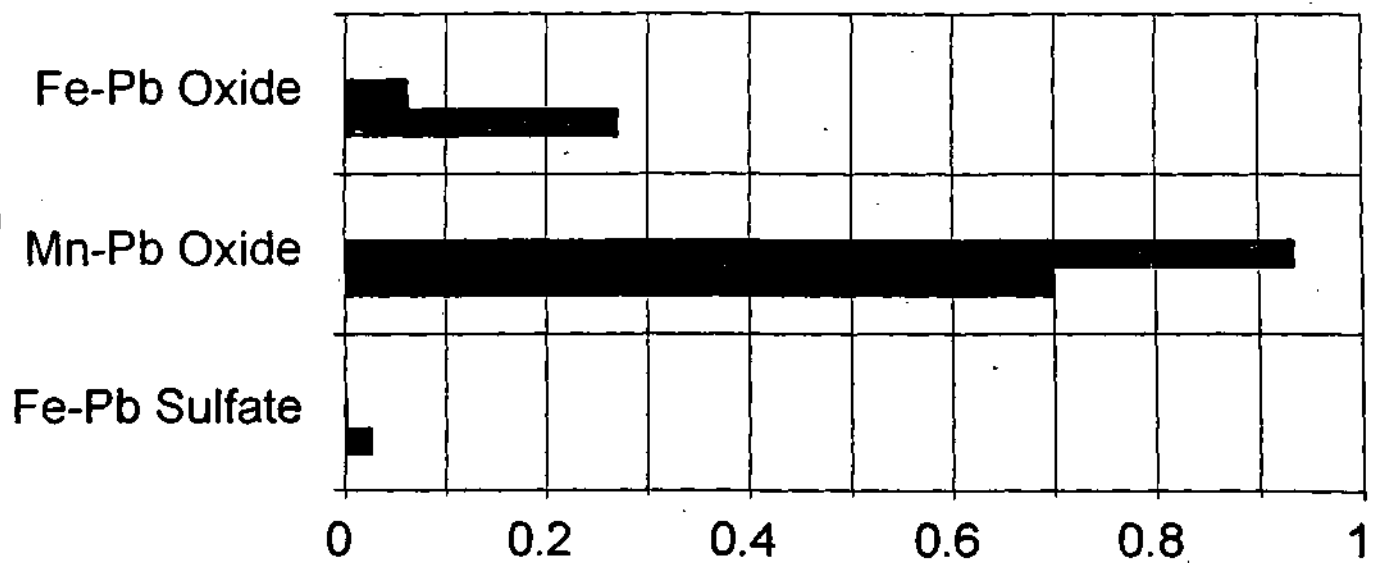
CDH

Sample RC-11



CDH

Sample RC-12



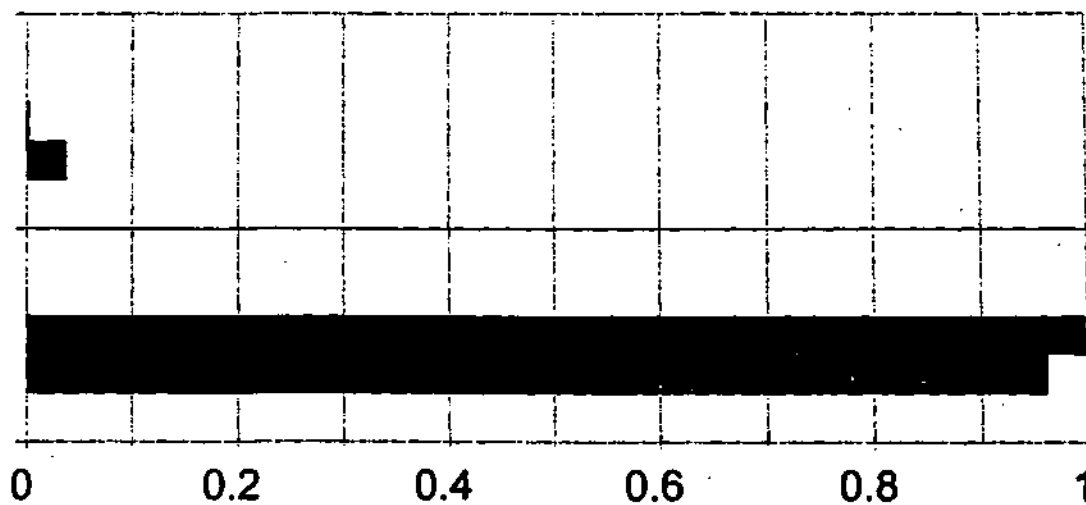
Frequency of Occurrence Relative Pb Mass

CDH

Sample RC-13

Fe-Pb Sulfate

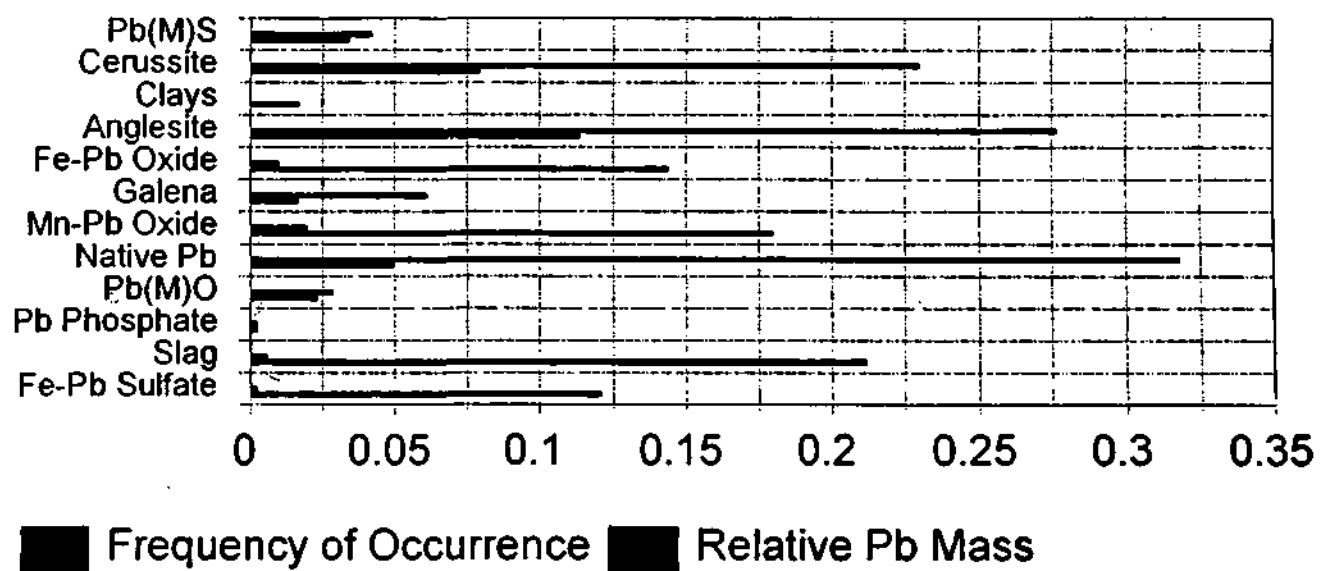
Mn-Pb Oxide



Frequency of Occurrence Relative Pb Mass

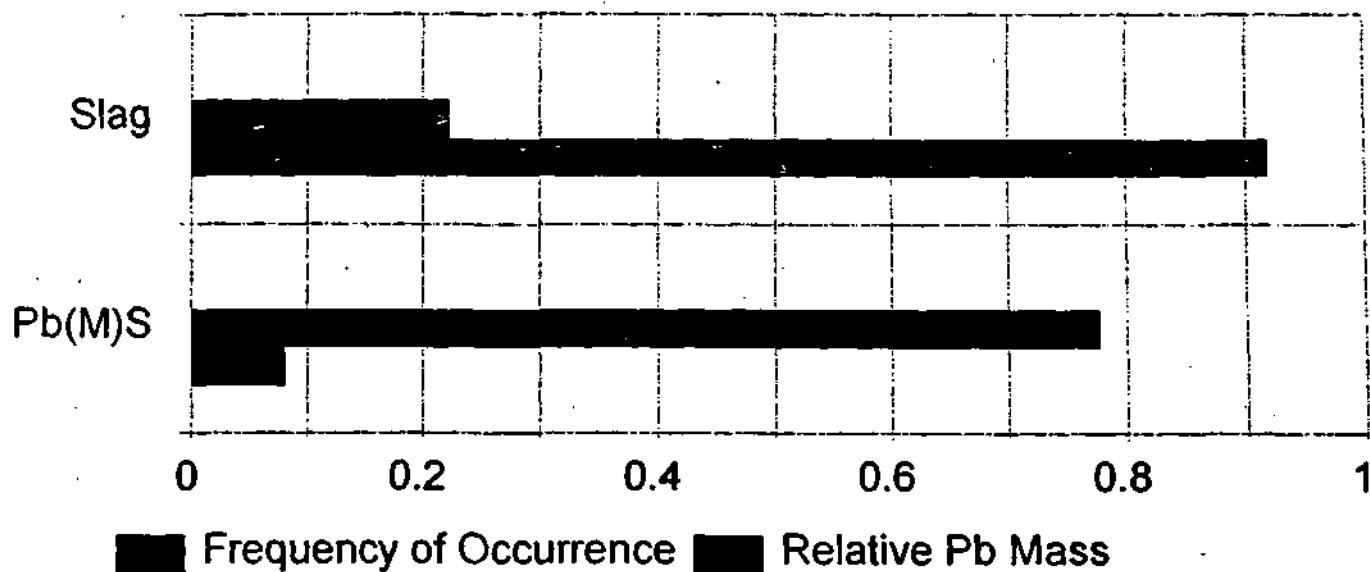
CDH

Sample RC-14



CDH

Sample RC-15



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Center at (303) 312-6473.

TABLE 2. Frequency distribution of lead-bearing phases from CDPH samples.

Phase	RC-11	RC-11	RC-12	RC-13	RC-14	RC-14	RC-15
Fe-Pb Sulfate	1.4%	7.6%	2.7%		12.4%	8.4%	
Pb Solder	Tr						
Pb Organics	21.6%	14.3%					
Mn-Pb Oxide	73.9%	69.8%	70.1%	96.1%	18.0%	2.2%	
Fe-Pb Oxide	2.5%	1.7%	27.2%	3.9%	14.4%	10.2%	
Clays	0.5%	Tr			1.7%		
Slag					21.2%	15.2%	91.9%
Pb Phosphate					0.3%		
Pb(M) Oxide					2.4%	1.6%	
Cerussite					7.9%	4.1%	
Galena					1.7%	Tr	
Anglesite					11.4%	7.1%	
Native Pb					5.3%	2.1%	
Pb(M) Sulfide					3.5%	2.8%	8.1%
Particles Counted	103		6	2	144		18

+/- Based on 95% confidence limit using method in Mosimann, 1965.

TABLE 2. EDSXRF Pb and As concentrations.

Sample	Pb mg/kg	As mg/kg
RC-11	1,300	12
RC-13	249	DL
RC-14	6500	120
RC-15	120	17

PHOTO 1. Backscatter photomicrograph from sample RC-11 of Mn-Pb oxide cementing non-lead bearing silicate fragments.

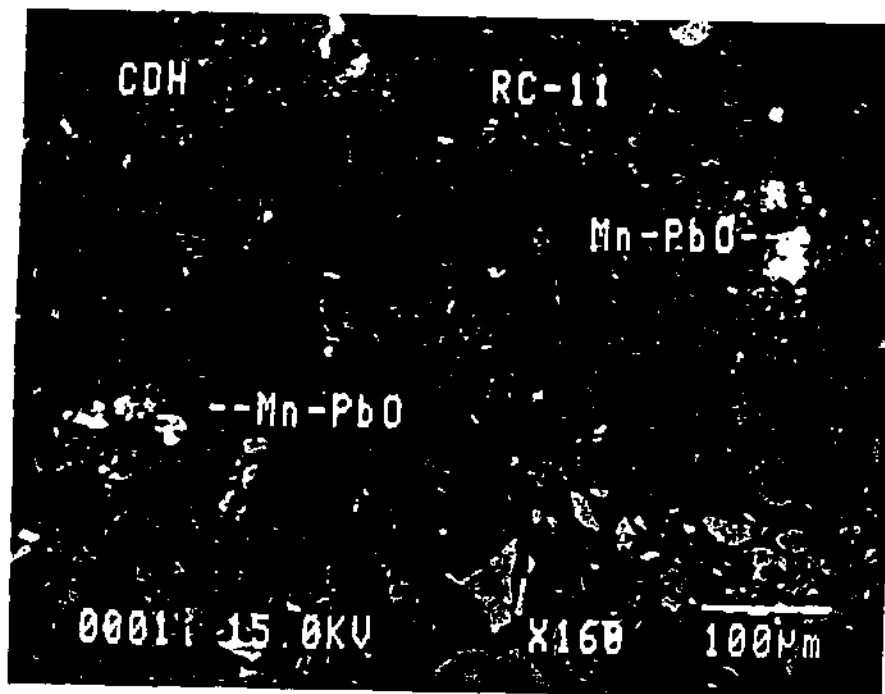
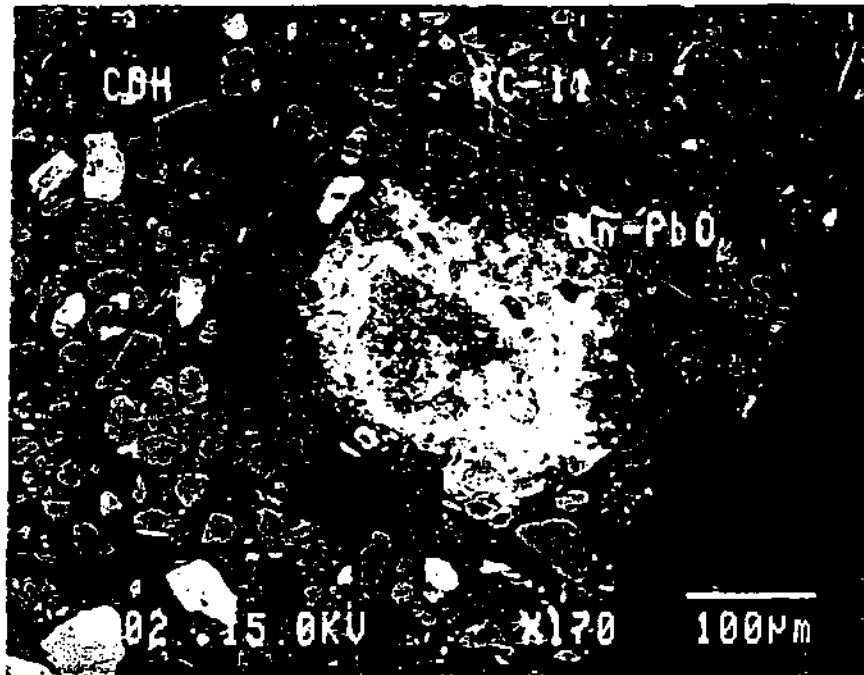


PHOTO 2. Backscatter photomicrograph of slag particle from sample RC-14 with enclosed Pb(M)S.

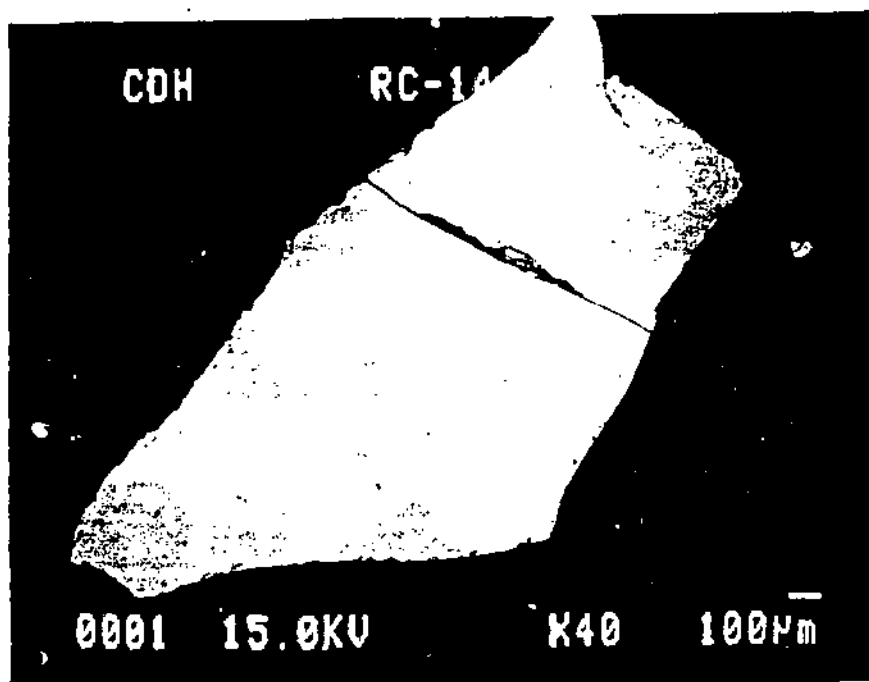


PHOTO 3. Backscatter photomicrographs from sample RC-14 with anglesite and Mn-Pb oxide forms of lead.

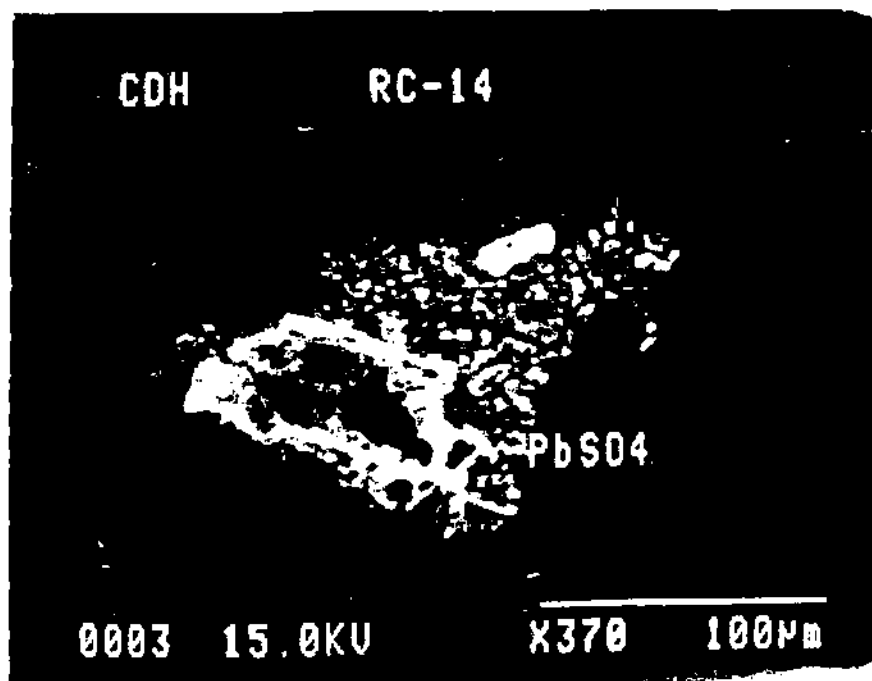
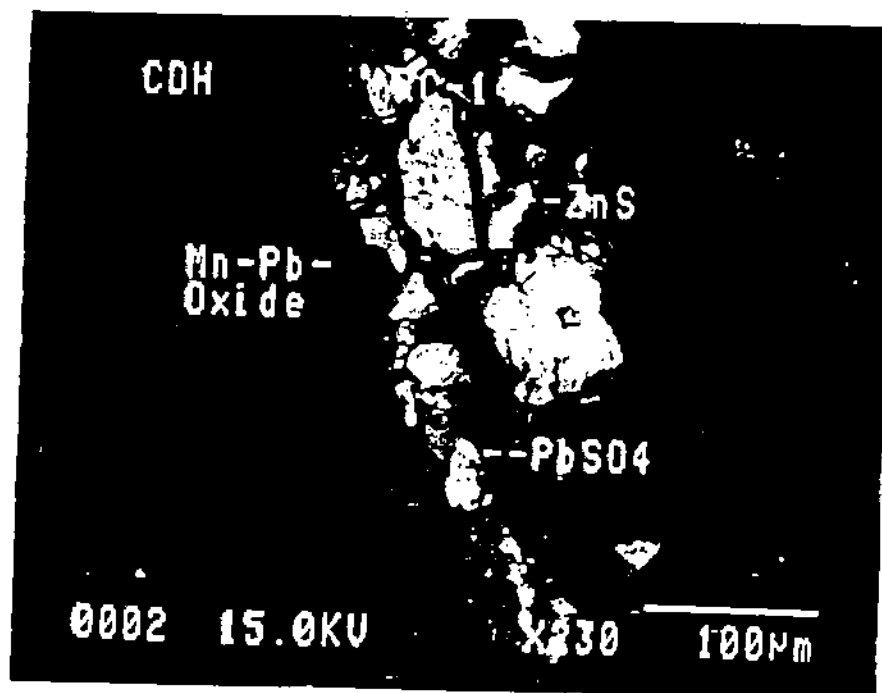
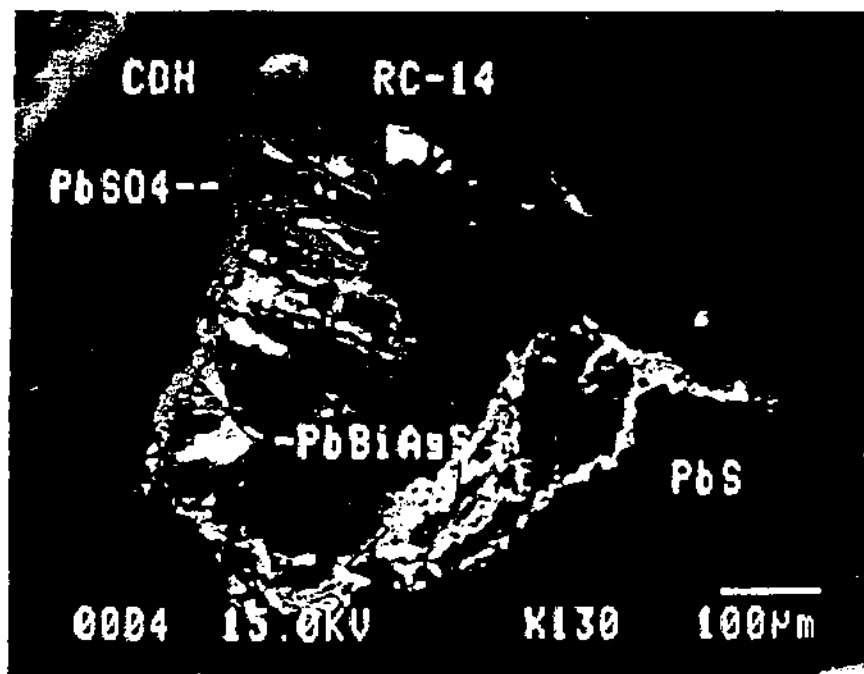


PHOTO 4. Backscatter photomicrograph from sample RC-14 with anglesite rimming galena and Pb-Bi-Ag sulfide.



October 25, 1996

TO: Mark Walker
FROM: John Drexler

RE: Rico Samples

Mark:

In reviewing your data set I believe it is very clear that three samples (RC-4b, RC-15, and RC-14) have been substantially impacted by mining wastes. These wastes include both smelting and tailings signatures. The other samples are more difficult to interpret. Each indicate a significant mass of lead in what I term "soil forming" phases, (Mn-oxide and Fe-oxide). Lead in these phases is likely to be of a secondary nature, adsorbing to these phases as it moves through the soil profile from the dissolution of the primary source.

The primary source of lead in this case could be mining waste, but I am not sure. One of the samples, RC-11, has its mass of lead in both Mn-oxide and soil organic matter. This sample also has very high bulk lead (1300 mg/kg) with NO mining signature. This would suggest to me that either leaded gas or old lead paint may be the primary source of lead.

TABLE 2. Frequency distribution of lead-bearing phases from CDPH samples.

Phase	RC-11	RC-12	RC-13	RC-14	RC-15	RC-4B
Fe-Pb Sulfate	1.4%	2.7%		12.4%		2.0%
Pb Solder	Tr					TR
Pb Organics	21.6%					
Mn-Pb Oxide	73.9%	70.1%	96.1%	18.0%		36.7%
Fe-Pb Oxide	2.5%	27.2%	3.9%	14.4%		59.2%
Clays	0.5%			1.7%		
Slag				21.2%	91.9%	
Pb Phosphate				0.3%		
Pb(M) Oxide				2.4%		TR
Cerussite				7.9%		
Galena				1.7%		TR
Anglesite				11.4%		TR
Native Pb				5.3%		
Pb(M) Sulfide				3.5%	8.1%	
Particles Counted	103	6	2	144	18	160

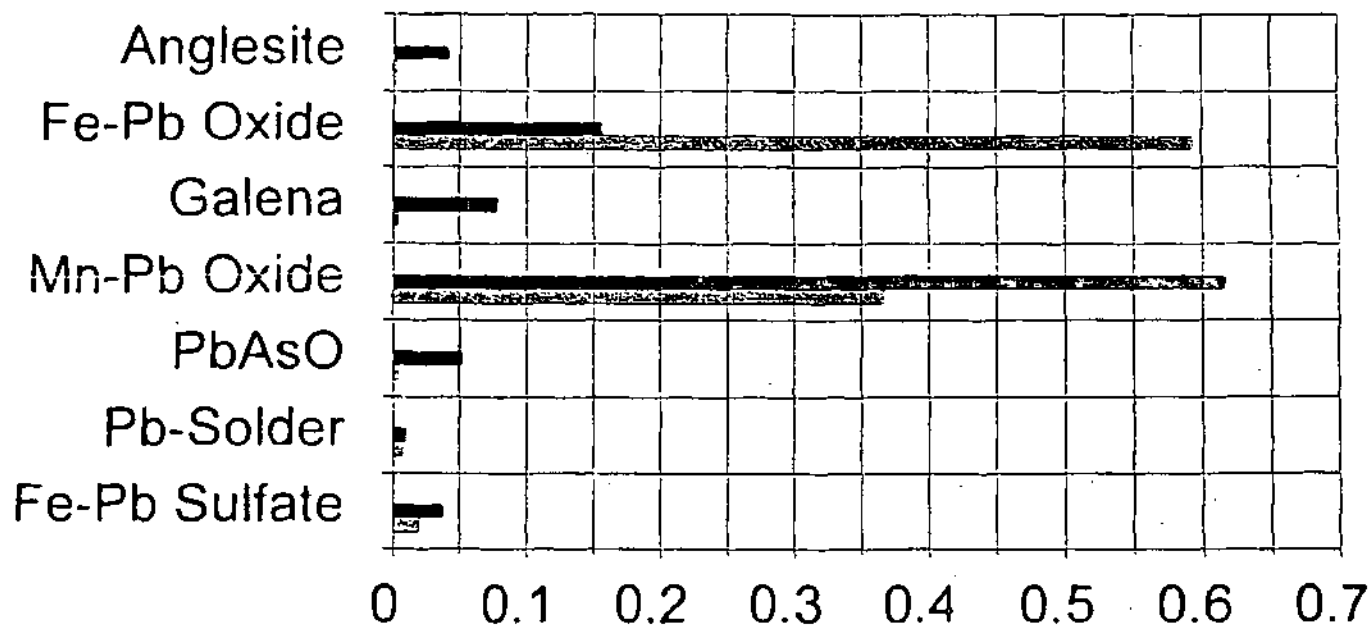
+/- Based on 95% confidence limit using method in Mosimann, 1965.

+/- Based on 95% confidence limit using method in Mosimann, 1965.

TABLE 2. EDSXRF Pb and As concentrations.

Sample	Pb mg/kg	As mg/kg
RC-4B	1,400	21
RC-11	1,300	12
RC-13	249	DL
RC-14	6500	120
RC-15	120	17

CDH RC-4B



 Frequency of Occurrence  Relative Pb Mass

APPENDIX B

**REPORT OF PH, CLAY MINEROLOGY, TCLP
ANALYSIS
AND DATA INTERPRETATION BY
ARCO EXPLORATION**

Fax Transmittal Memo

7672

No. of Pages 4

Today's Date

Time

To Mark Walker
Company

From Terry Moore
Company

Location

Dest. Charge

Fax #

Telephone #

Fax #

Telephone #

Comments

Original Disposition:

☐ Destroy

☐ Return

☐ Call for pickup

Arch Document At 11:15

Environmental Laboratories

Bethany Tech Center • Suite 190
400 W. Bethany Rd. • Allen, Texas 75013

September 13, 1996

REPORT OF:

Soil Analysis (P.O. #RICO)

REPORT TO:

Mr. Terry Moore
ARCO Exploration and Production Tech.
2300 W. Plano Parkway
Plano, Texas 75075

PROJECT NAME:

RICO

SAMPLE I.D.:

See Below

SAMPLE RECEIVED:

September 06, 1996

TIME RECEIVED:

11:05AM

SAMPLE COLLECTED BY:

Customer

SAMPLE NUMBER:

See Below

RESULTS:

Sample
Number

Sample
I.D.

Cation Exchange Capacity
(meq/100g)

64811

RC-2C

14

64812

RC-2A

18

64813

RC-7B

24

64814

4B

32

Detection Limit

0.10

Quality Control Information

Parameter	Sample Preservation	EPA Method	C.V. %	Standard Deviation	Spike Recovery %	Date of Analyses	Time of Analyses	Analyst
Extraction	Cool to 4°C	9081	0.7	± 0.07	99	09/12/96	2:00PM	F. Coskey
GEC		9081				09/12/96	3:00PM	S. Isaac

Respectfully submitted,

X-RAY DIFFRACTION DATA - "RICO" SOIL SAMPLES

K/T Sample # Sample I.D.	1 RC-2A	2 RC-2C	3 RC-3A	4 4B	5 4C	6 RC-7A	7 RC-7B	8 RC-9A
Whole Sample Mineralogy (Weight Percent)								
Quartz	55.8%	48.1%	49.2%	50.6%	52.5%	40.9%	41.0%	50.8%
K-Feldspar	7.0%	8.6%	5.2%	7.6%	4.0%	12.6%	12.1%	8.6%
Plagioclase	11.4%	17.4%	15.9%	12.5%	9.8%	9.9%	10.9%	16.2%
Hornblende	0.0%	1.1%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%
Calcite	0.3%	0.0%	0.9%	0.0%	0.0%	0.4%	0.3%	0.2%
Pyrite	0.2%	0.0%	1.7%	0.3%	0.0%	0.4%	0.0%	0.0%
Hematite	1.2%	2.3%	1.1%	0.6%	1.3%	1.4%	2.4%	2.0%
* Laumontite	0.0%	0.0%	1.5%	3.4%	1.6%	1.5%	0.0%	1.0%
* Heulandite or Clinoptilolite	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Total Phyllosilicates	23.7%	22.6%	24.4%	24.6%	30.8%	33.0%	33.4%	20.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Phyllosilicate Mineralogy (Relative Abundance)								
Mixed-Layer Illite/Smectite *	24.6%	13.6%	2.6%	16.0%	34.0%	15.5%	14.2%	11.8%
Illite & Mica	56.2%	66.3%	62.5%	39.7%	48.6%	55.6%	60.1%	59.3%
Kaolinite	6.1%	9.2%	4.5%	12.7%	7.4%	9.0%	7.2%	7.4%
Chlorite	13.1%	10.9%	30.3%	31.6%	10.1%	19.8%	18.4%	21.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*-R=0, 70-80% S-Layers

* Zeolite

K/T GEOSERVICES, INC.**SAND/SILT AND CLAY-FRACTION ANALYTICAL PROCEDURES****Sample Preparation**

Samples submitted for XRD analysis are first disaggregated using a mortar and pestle, weighed, and dispersed in a dilute sodium phosphate solution using a sonic probe. The samples are next centrifugally size-fractionated into a bulk (>4 microns) and a clay-size (<4 microns ESD) fraction. The clay suspensions are then decanted and vacuum-deposited on silver metal membrane filters to produce oriented mounts. Clay mounts are then attached to glass slides and exposed to ethylene glycol vapor for a minimum of 24 hours to aid in detection and characterization of expandable clays. The bulk fractions of each sample are dried and weighed in order to determine weight loss due to removal of clay-size materials, and then pulverized in water using a McCrone micronizing mill. The resultant powders are then packed into aluminum powder mount holders to produce random mounts.

Analytical Procedures

XRD analyses of the bulk and clay-size fractions of the samples are performed using a Scintag, Rigaku, or Siemens automated powder diffractometer equipped with a CuK α radiation source (40 Kv, 35 mA) and a solid state or scintillation detector. The glycol-solvated oriented clay mounts are analyzed over an angular range of 2-50 degrees 2 θ at a scan rate of 1.5 degrees/minute. The random powder mounts are analyzed over an angular range of 2-60 degrees 2 θ at a rate of one degree/minute using a sample spinner to reduce the effects of preferred orientation.

Quantitative analyses of the diffraction data are done using integrated peak areas (derived from peak deconvolution / profile-fitting techniques) and empirical reference intensity ratio (RIR) factors determined specifically for the diffractometer used for data collection. The weight fractions of the clay minerals (and clay-size rock-forming minerals) are determined for the clay mounts of each sample and normalized to the weight percent clay-size material determined by the weighing procedure described above. The weight fractions of the minerals present in the random powder mounts (including >4 micron clay minerals) are calculated and normalized to the weight percent sand/silt material. The whole-rock compositions are then determined by mathematically combining the XRD data from both size fractions. Determinations of mixed-layer clay ordering and percent expandable interlayers are done by comparing experimental diffraction data from the glycol-solvated clay aggregates with simulated one dimensional diffraction profiles generated using the program NEWMOD written by R. C. Reynolds.

Data reported in the table and provided to you as a spreadsheet or other computer-readable file are formatted as weight percent, but are actually calculated as weight fractions. Therefore, slight rounding errors may be observed in the formatted data.

Sample Number	pH	Mineralogy in Progress
RC-02A	5.18	X
RC-02B	5.77	
RC-02C	5.34	X
RC-02D	5.98	
RC-02E	6.27	
RC-02F	6.27	
RC-03A	6.21	X
RC-03B	5.45	
RC-03C	5.53	
RC-04B	6.65	X
RC-04C	6.51	X
RC-06A	7.15	
RC-07A	5.81	X
RC-07B	6.03	X
RC-08E	6.15	
RC-09A	6.25	X
RC-09B	6.75	
RC-16A	6.74	
RC-21A	6.77	
RC-21B	6.97	
RC-21C	7.08	

pH was measured at a 2:1 DI water to soil ratio with overnight equilibration.



ARCO Exploration and
Production Technology
2300 West Plano Parkway
Plano, TX 75075-6495
Telephone 214 754 3000

November 5, 1996

Mark Walker
Colorado Dept. of Public Health
4300 Cherry Creek Drive South
Denver CO 80222-1530
Fax: 303/759-5355

As we discussed, selected soil samples from the Rico area were subjected to additional analyses. Samples included RC-4C, RC-4B, and RC-8B. These were selected because of lead concentrations in excess of 1000 mg/kg in the vicinity of the historic Grandview Smelter. Sample RC-4C was submitted because it is a low Pb sample in the same vicinity.

Samples were size fractionated by sieving and sedimentation. Size fractions collected include: whole soil (no fractionation), sand (0.05 - 2 mm), silt (2 - 50 um), and clay (<2 um). Soil fractions were analyzed using wet chemistry, optical microscopy, scanning electron microscopy, and energy dispersive x-ray analysis.

Chemical analyses of whole-soil and sand fractions of soil are as follows.

<u>Sample</u>	<u>Original Pb Analysis (mg/kg)</u>	<u>Whole Soil Pb (mg/kg)</u>	<u>Sand Pb (mg/kg)</u>	<u>Silt Pb (mg/kg)</u>	<u>Clay Pb (mg/kg)</u>
RC-4b	7000	739	398	1140	2540
RC-4c	240	124	112	138	815
RC-8b	1000	623	954	659	420

In general, the original soil analyses are higher than those performed on whole-soil samples during this accessory study. Sample RC-4B, however, is an order of magnitude lower in Pb content than the original analysis. The laboratory in Allen, Texas, performed an additional QC step to ensure that a dilution factor was not overlooked. If there was actually an order of magnitude of variability in soil Pb concentrations, it would suggest that high Pb concentrations are contained primarily in very coarse-grained particles. The data do not bear this out.

If Pb is inherited from the colluvium from which the soil is weathered, we would expect to see some Pb in the sand-sized fraction and increasing concentrations in finer fractions. This trend is illustrated in samples RC-4b&c. Sand fractions contain some Pb; however, Pb increases in fine fractions where surface area and attenuation capacity increase. Smelter-related waste would typically consist of slag particles or aerial emissions that would occur predominately in the silt and fine sand fractions. Sample RC-8b does not follow the trend of RC-4b&c. Concentrations of Pb are actually higher in the sand fraction. This trend makes it critical to observe the mineralogical composition of Pb-bearing phases to ensure that they don't reflect a high-temperature history.

Samples 4-B and 8-B were also subjected to investigations using the optical microscope and electron microscope to determine if Pb was held in high temperature mineral phases characteristic of air emissions. The fine sand fraction of the soils was examined under the optical microscope and any particles with a glassy or cenosphere morphology were isolated. These particles, in addition to the rest of the sand fraction, were then examined under the electron microscope and analyzed using energy dispersive X-ray spectroscopy.

lustre

All of the vitreous, or rounded particles contained in the sample were analyzed and determined to be organic in origin. Lead was apparently dispersed throughout the matrix of particles and very few seemed to be dominated by Pb. Those that were predominately Pb were fine sand-sized particles consisting of Pb and S (this could potentially be any of a number of Pb sulfides or sulfate minerals characteristic of natural weathering from bedrock, colluvium, or from mining waste). There was no evidence of high temperature phases in samples 4b or 8b, and, therefore, no Pb associated with high temperature phases.

Drexler's Analyses

The report by Drexler suggests that samples RC-14, RC-15, and RC-4b have been "substantially impacted" by mining waste. Alternative explanations for soil Pb in these samples may be appropriate, if other field and laboratory data are considered.

Samples RC-14 and RC-15

Samples RC-14 and RC-15 have evidence of primary sulfides (a predominant component of Pb ore) and slag (a waste product of high temperature processing of ores). Both samples were collected from areas where visual evidence of waste was apparent. The soil sample collected at RC-14 consisted of disturbed materials over a truncated soil profile. The disturbed material contained visual evidence of ore materials, deposited from the historic railroad ore-loading chute located adjacent to the sampling location. Sample RC-15 was collected at the base of a structural fill that contained a variety of debris used to level the site for construction of the historic buildings along the highway. Although RC-15 did not contain visual fragments of Pb phases, the total Pb content was low and suggests small amounts of contribution from the structural fill.

Sample RC-14 contained significant primary sulfides, in addition to weathering products (i.e., sulfates and phosphates) and other phases attenuated by soils (i.e., Fe and Mn oxides, and clays). The sample also contained slag, characteristic of high temperature processing of ores. Overall, the sample contained 5,600 mg/kg Pb in the form of Pb ores, weathering products, and slag (smelter related). We would agree with Drexler's interpretation.

Sample RC-15 contained Pb primarily in the form of slag. Although slag was not specifically noted in field observations, it is conceivable that minor amounts of slag might have been beneficially reused in the structural fill of historic business buildings along the highway in Rico. The concentrations of Pb in the soil at RC-15 was actually below values considered to be typical of background in the area (110 mg/kg). The Pb was also not mobile as defined by the Toxicity Characteristic Leaching Procedure, with a value of 0.16 mg/L Pb. Although the soil may have amounts of Pb in soil that may be attributable to slag, it is probably not "significant" as described in the findings of Drexler.

Sample RC-4b

Sample RC-4b differs from RC-14 and RC-15 in that smelter-related forms of Pb were not identified. In the case of RC-4b, we would argue that Pb from the sample may be neither significant nor mining waste related.

Sample RC-4b differs from RC-14 in the degree of weathering of the material. Recognizable concentrations of primary Pb sulfides and weathering intermediates are present in sample RC-14. Those materials are almost completely weathered from sample RC-4b, with only trace amounts of sulfides and sulfates present. The vast majority of Pb

is held in oxide forms in the fine fraction, consistent with weathering and attenuation by the soil. Although this could be a signature of mining-related materials that had a very long period of time for weathering to occur, it is more likely related to natural weathering of the parent material of the RC-4b site. Mineralized Hermosa formation materials occur upslope from the RC-4b site and contribute to the colluvium that constitutes parent material for soils at RC-4b. Pyrite was identified in RC-4b by X-ray diffraction, illustrating the mineralized nature of the materials.

The soil formed at site RC-4b is perfectly consistent with weathering of the mineralized parent material. The Pb is contained predominately in Fe- and Mn-oxides and most heavily concentrated in the fine fraction. Primary sulfides and weathering products have weathered almost completely from the mineralogical suite. Integrating the information from Drexler's work, subsequent chemical analyses, field notes, and surrounding geology, it is most likely that the Pb distribution in Sample RC-4b reflects natural weathering of sulfide-containing parent materials. The existence of sulfides in the soil parent material was probably data that Drexler did not have when describing his results.

Another important aspect of sample RC-4b is the lack of Pb-containing high-temperature mineral phases. The investigation of Drexler and subsequent fractionation/wet chemical testing have shown no evidence of smelter-related materials. Additional testing of silt-sized fractions will continue to be pursued to determine if air emissions could be a potentially limited Pb input. Presence or absence of smelter-related materials was the hypothesis being tested by sampling at RC-4b. These data coupled with the very limited life-span of the Grandview Smelter do not support the presence of Pb-impacted soils surrounding the historic Grandview site.

Sample RC-8b

Testing for sample RC-8b yielded results similar to RC-4b. Drexler's data suggest a similar, yet more thorough, weathering of sulfide-containing parent material. The majority of Pb content was in the Mn- and Fe-oxide fractions. The high organic matter content of RC-8b was reflected in a high organic-Pb fraction. Photomicrographs of particles from RC-8b feature a pedogenic manganese concretion that has encapsulated silicate skeletal grains of the soil. Attenuation of Pb in these sand-sized concretions results in a bias of Pb in the coarser soil fractions due to the tendency of the Mn minerals to form sand-sized concretions. Sample RC-8b actually has greatest concentrations in the sand-sized fraction. These manganese concretions contain Pb and consistent with the weathering and attenuation mechanisms that would be expected during natural weathering of sulfide-containing parent materials.



Terry Moore
ARCO Environmental Technology

cc: Richard Elliot 486-1740
Travis Hudson 360/681-5107



ARCO Exploration and
Production Technology
2300 West Plano Parkway
Plano, TX 75075-6499
Telephone 214 754 3000

November 5, 1996

Mark Walker
Colorado Dept. of Public Health
4300 Cherry Creek Drive South
Denver CO 80222-1530
Fax: 303/759-5355

Re: Preliminary Interpretation of Mineralogy and CEC Data

Clay mineralogy and Cation Exchange Capacity (CEC) data suggest that soils from Rico have a high affinity for positively charged particles and accompanying ability to attenuate metals.

Total phyllosilicate (clay-type minerals by X-Ray Diffraction-XRD) contents range from 23 to 33% by weight. The clay-sized fraction of soil is probably greater than 30% on most soils. Clay minerals consist of mixed-layer illite/smectite, illite and mica, kaolinite, and chlorite. The mixed-layer illite/smectite minerals have the highest surface area and exchange properties, followed by illite. Cation exchange values for soils range from 14 to 32 meq/100g of soil weight. These are relatively high values and reflect a large capacity to attenuate Pb and other cationic metals. Iron and manganese oxide minerals are very prevalent in all soils from Rico (ranging from 0.6 to 2.4% by weight). Manganese minerals are not easily identified using XRD. Iron and manganese minerals are very important because of their ability to attenuate Pb.

One of the primary purposes of clay mineralogy was to determine if acid sulfate weathering had caused excessive weathering of soils. Soils near the historic acid plant (RC-7a&b) were of specific interest. Intense weathering of soils would result in transformation of primary clay minerals to more stable forms such as kaolinite. Smectite, illite, and mica should diminish in concentration, while kaolinite increases. The data do not support this relationship. The presence of calcite and potentially zeolites is also evidence that soils are not heavily weathered. Chlorite may occur in soils in two forms: primary or pedogenic chlorite. Pedogenic chlorite (aluminum interlayered) develops due to extreme weathering of other primary minerals. The chlorite in Rico soils is primary chlorite (magnesium interlayered) based on discussions with Mark Walthall (Louisiana State University), who did his dissertation on soil mineralogy in mountain valleys of Colorado. Existence of primary chlorite is also evidence that soils have not been weathered heavily by acid sulfate weathering or acid deposition from the historic acid plant.

Occurrence of pyrite in XRD analysis suggests that soils may contain mining-related waste or have been weathered from sulfide-containing parent materials. Pyrite was identified in RC-2a, RC-3a, RC-4b, and RC-7a. Mining contamination was only apparent at site RC-3a. Samples RC-2a, RC-4b, and RC-7a do not appear to have mining waste additions, but soils in these locations are weathering from colluvium that has moved downslope from mineralized outcrops of Hermosa formation. These soils are weathering from parent materials that contain or have contained sulfide materials such as Pb-sulfide (galena). Site RC-4b has been somewhat disturbed, but locations RC-2a and RC-7a are undisturbed and potential input from mining related activities is very remote. Sample RC-7a is within mineralized portions of the Hermosa formation, but geochemical zonation is such that Pb-bearing minerals do not occur in abundance that far north of Rico.



Terry Moore
ARCO Environmental Technology

cc: Richard Elliott 486-1740
Travis Hudson 360/681-5107

To: Richard Elliot
c/o Mark Walker
From: Terry Moore
Subject: Rico Data
Date: November 13, 1996

Description and two attached SEM photos.

The major Pb-containing phase at site RC-8b was Mn-Pb coprecipitated materials. One of the major types of coprecipitation was illustrated in Drexler's memo, showing a pedogenic Mn-concretion that has grown and encased skeletal grains of the soil. The concretions are quite large, which matches the results of fractionation studies that show maximum lead concentrations in the sand fraction. The second most common type of Pb-bearing particles are shown in the attached SEM photograph. The particle appears to be a shale particle (or the impression of a shale particle on an adjacent soil aggregate) that has precipitated a coating of Mn-oxides on the surface. The banding is probably not the bedding in the shale, but the Mn-oxides that have migrated out of the shale beds and precipitated. The Mn-coatings have an enrichment of Pb from coprecipitation and attenuation in the soil. The attached dot map of lead illustrates enrichment of lead in the particle coatings and in some of the particle fragments surrounding the main particle. The dimensions of the particle are about 0.3 X 0.4 mm (scale bar at the bottom is 100um). The large diameter of this particle is not consistent with any type of airborne particle. Pedogenic forms of Pb (Mn & Fe oxides) were the only phases noted in our study of RC-8b. These phases are most likely derived from weathering of sulfide-containing rock fragments inherited from the mineralized Hermosa formation.

APPENDIX C

LABORATORY DATA SHEETS ANALYTICA LABORATORIES

Facsimile Cover Page

Analytica Environmental Laboratories, Inc.
325 Interlocken Parkway Suite 200
Broomfield, CO 80021



Voice: (303) 469-8868 Fax: (303) 469-5254

Sender: James D. Robinson

Sent: Friday, Aug 23, 1996 12:06 p.m.

To:

Company: CDPHE
Phone:
FAX: 759-5355

Please Deliver to:

John Aaron

Pages: 15

Message:

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Cathy Inman

Haz. Material & Waste Mgmt.
Colorado Dept. of Health
4300 Cherry Creek Drive South
Denver, CO 80222-1530
Attn: John Aaron

Order #: 96-08-076
Date: 08/23/96 11:17
Work ID: RICO/ARCO
Date Received: 08/09/96
Date Completed: 08/22/96

SAMPLE IDENTIFICATION

<u>Sample Number</u>	<u>Client Description</u>
01	RC 3C
02	RC 21 B
03	RC 21 C
04	RC 21 A
05	RC 2 A
06	RC 2 B
07	RC 2 C
08	RC 2 D
09	RC 2 E
10	RC 2 F
11	RC 8 B
12	RC 5A 2
13	RC 5A 1
14	RC 5A 3
15	RC 6A
16	RC 9A

<u>Sample Number</u>	<u>Client Description</u>
17	RC 10C
18	RC 10B
19	RC 7A
20	RC 9B
21	RC 7B
22	RC 4A
23	RC 3A
24	RC 16A
25	RC 4B
26	RC 4C
27	RC 6B
28	RC 3B
29	RC 8A
30	RC 5B
31	RC 10A

Enclosed are the analytical results for the submitted sample(s). Please review the CASE NARRATIVE for a discussion of any data and/or quality control issues. A listing of data qualifiers and analytical codes is located on the TEST METHODOLOGIES page at the end of the report.

If you have any questions regarding the analyses, please feel free to call.

Sincerely,

J. D. Robinson
Project Manager

Samples were prepared and analyzed according to methods outlined in the following references:

- o Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publications SW-846 [Third Edition (September, 1986), as amended by Revision 3 (January, 1995)]
- o Solid and waste samples are reported on a "dry weight" basis, i.e. correction is made for moisture content.

All analyses meet quality assurance objectives.

Sample: 01A RC 3C

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		660		5.5	mg/Kg-DRY	08/22/96
Percent Moisture	ASTM D2216	8.30		0.1	WT%	08/14/96

Sample: 02A RC 21 B

Collected: 08/08/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		1300		5.2	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	3.90		0.1	WT%	08/14/96

Sample: 03A RC 21 C

Collected: 08/08/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		2300		5.4	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	7.80		0.1	WT%	08/14/96

Sample: 04A RC 21 A

Collected: 08/08/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		1800		5.3	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	5.70		0.1	WT%	08/14/96

Sample: 05A RC 2 A

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		220		5.4	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	7.20		0.1	WT%	08/14/96

Sample: 06A RC 2 B

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		75		5.4	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	7.60		0.1	WT%	08/14/96

Sample: 07A RC 2 C

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		69		5.6	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	10.0		0.1	WT%	08/14/96

Sample: 08A RC 2 D

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		1200		5.4	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	7.80		0.1	WT%	08/14/96

Sample: 09A RC 2 E

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		3000		5.6	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	10.8		0.1	WT%	08/14/96

Sample: 10A RC 2 F

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		3600		5.6	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	10.1		0.1	WT%	08/14/96

Sample: 11A RC 8 B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		1000		5.6	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	10.4		0.1	WT%	08/14/96

Sample: 12A RC 5A 2

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		72		5.0	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	0.700		0.1	WT%	08/14/96

Sample: 13A RC 5A 1

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		14		5.0	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	0		0.1	WT%	08/14/96

Sample: 14A RC 5A 3

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		8.9		5.0	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	0.500		0.1	WT%	08/14/96

Sample: 15A RC 6A

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		1100		5.3	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	5.30		0.1	WT%	08/14/96

Sample: 16A RC 9A

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		330		5.2	mg/Kg-DRY	08/20/96
Percent Moisture	ASTM D2216	3.90		0.1	WT%	08/14/96

Sample: 17A RC 10C

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		110		5.4	mg/Kg-DRY	08/22/96
Percent Moisture	ASTM D2216	7.60		0.1	WT%	08/14/96

Sample: 18A RC 10B

Collected: 08/07/96

Matrix: SOIL

Test Description	Method	Result	Q	Limit	Units	Analyzed
ICP Metals, Total	SW 6010					
Lead		430		5.3	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	6.00		0.1	WT%	08/14/96

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TEST RESULTS by SAMPLE

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Sample: 19A RC 7A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		130		5.5	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	9.50		0.1	WT%	08/14/96

Sample: 20A RC 9B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		670		5.3	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	5.50		0.1	WT%	08/14/96

Sample: 21A RC 7B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		86		5.3	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	6.50		0.1	WT%	08/14/96

Sample: 22A RC 4A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		2200		5.4	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	7.80		0.1	WT%	08/14/96

Sample: 23A RC 3A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		5600		5.6	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	10.2		0.1	WT%	08/14/96

Sample: 24A RC 16A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		110		5.4	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	6.80		0.1	WT%	08/14/96

Sample: 25A RC 4B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		7000		5.4	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	8.00		0.1	WT%	08/14/96

Sample: 26A RC 4C

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		240		5.4	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	7.80		0.1	WT%	08/14/96

Sample: 27A RC 6B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		340		5.1	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	1.50		0.1	WT%	08/14/96

Sample: 28A RC 3B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		550		5.3	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	5.50		0.1	WT%	08/14/96

Sample: 29A RC 8A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		38		5.0	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	0.200		0.1	WT%	08/14/96

Sample: 30A RC 5B

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u>	<u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010					
Lead		ND		5.0	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	0.500		0.1	WT%	08/14/96

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TEST RESULTS by SAMPLE

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Sample: 31A RC 10A

Collected: 08/07/96

Matrix: SOIL

<u>Test Description</u>	<u>Method</u>	<u>Result</u> <u>Q</u>	<u>Limit</u>	<u>Units</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010				
Lead		ND	5.0	mg/Kg-DRY	08/21/96
Percent Moisture	ASTM D2216	0.500	0.1	WT%	08/14/96

THE FOLLOWING CODES APPLY TO THE ANALYTICAL REPORT

RESULT field...

ND = not detected at the reported limit

NA = analyte not applicable (see case narrative/methods for discussion)

Q (qualifier) field...

GENERAL:

* = Recovery or %RPD outside method specifications

H = value is estimated due to analysis run outside EPA holding times

E = reported concentration is above the instrument calibration range

D = analyte was diluted to bring within instrument calibration range or
to remove matrix interferences

ORGANIC ANALYSIS DATA QUALIFIERS:

B = analyte was detected in the laboratory method blank

J = analyte was detected above the instrument detection limit (IDL)
but below the analytical reporting limit (CRDL)

INORGANIC ANALYSIS DATA QUALIFIERS:

B = analyte was detected above the instrument detection limit (IDL)
but below the analytical reporting limit (CRDL)

A = post digestion spike did not meet criteria (70-130%), therefore the
reporting limit was raised by a factor of two to reflect spike failure

S = reported value determined by the Method of Standard Additions

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TEST METHODOLOGIES

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3050_I: Acid Digestion of Sediments, Sludges, and Soils METHOD: 3050A
for ICP Metals

ICP_TS: METALS, Total (ICP) METHOD: 6010

PMOIST: PERCENT MOISTURE METHOD: ASTM D2216

Sample: 01A RC 3C

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/22/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 02A RC 21 B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/08/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/08/96	08/09/96	NA		08/14/96

Sample: 03A RC 21 C

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/08/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/08/96	08/09/96	NA		08/14/96

Sample: 04A RC 21 A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/08/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/08/96	08/09/96	NA		08/14/96

Sample: 05A RC 2 A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 06A RC 2 B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 07A RC 2 C

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 08A RC 2 D

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

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DATES REPORT

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Sample: 09A RC 2 E

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 10A RC 2 F

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 11A RC 8 B

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 12A RC 5A 2

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 13A RC 5A 1

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 14A RC 5A 3

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 15A RC 6A

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 16A RC 9A

Matrix: SOIL

Analysis	Method	Collected	Received	TCLP date	Extracted	Analyzed
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/13/96	08/20/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 17A RC 10C

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/22/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 18A RC 10B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 19A RC 7A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 20A RC 9B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 21A RC 7B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 22A RC 4A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 23A RC 3A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 24A RC 16A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 25A RC 4B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 26A RC 4C

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 27A RC 6B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 28A RC 3B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 29A RC 8A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 30A RC 5B

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96

Sample: 31A RC 10A

Matrix: SOIL

<u>Analysis</u>	<u>Method</u>	<u>Collected</u>	<u>Received</u>	<u>TCLP date</u>	<u>Extracted</u>	<u>Analyzed</u>
ICP Metals, Total	SW 6010	08/07/96	08/09/96	NA	08/20/96	08/21/96
Percent Moisture	ASTM D2216	08/07/96	08/09/96	NA		08/14/96